eters (**64**,**65**,**66**), the buoy's pitch and roll, the expected Earth's magnetic flux at the buoy location, and correcting factors for the electro-magnetic effects of the hull and on-board electronics. The expected Earth's magnetic flux may be determined from the mean flux measurements or from a magnetic flux model. If used, the model information is entered into the DDWM before deployment.

The determined orientation of the buoy is applied to the directional components in the buoy hull coordinate system to produce directional data with respect to Magnetic North. Finally the directional data are transformed to True North by applying the known magnetic declination at the buoy location to the magnetic results. The magnetic declination is entered into the DDWM before deployment.

The datalogger **20** adds the wave spectral data message to the environmental data message of the other on-board measuring systems (for example, anemometers and barometers) and transmits the message to the shoreside processing system **103** from an on-board transmitter **101** via satellite **102**. The shoreside system **103** generally receives the wave data within 30 minutes of the conclusion of the wave sampling period.

The shoreside processing system **103** decodes the messages, processes the wave data, computes derived wave parameters, performs automated quality control, and then encodes the wave data for further dissemination. The shoreside processing applies algorithms to the acceleration spectra to remove noise caused by the tilting of the buoy and adjusts the acceleration spectra by applying transfer functions for the hull-mooring response and the sensor responses. After the acceleration spectra are corrected and adjusted, the acceleration spectra are transformed into displacement spectra by double integration. Double integration is accomplished in the frequency domain by dividing the spectra by the radian frequency to the fourth power. Corrections or adjustments may or may not be made to the directional spectra. From the displacement spectra various wave parameters may be derived, such as Significant Wave Height, Dominant or Peak Period (the inverse of the frequency that has the maximum spectral density within the spectrum), Average Period, and Mean Wave Direction at the Dominant Period. The shoreside processing facility also has the capability to reprocess the received spectral data using different response functions.

FIG. **2** is a block diagram illustrating the process of the present invention. Source code for these algorithm portions is shown in Appendices A and B attached herewith. Referring to FIG. **2**, in step **200**, the real-time clock is initialized to a default time of 01/01/00 00:00:00. In step **205**, the parameter table is loaded from the EPROM. In step **210**, the system baud rate is setup up, along with the clock rate. In step **215**, data is then collected for 20 minutes.

In step **220**, the raw data is stored to flash memory (if setup to do so) and in step **225**, collected data is loaded into global arrays used in processing. In step **230**, a mean pitch and roll of the buoy is calculated from acceleration data from accelerometers and rate sensors in the buoy. In step **235**, collected wave data based on mean pitch and roll is then processed. In step **240**, a message is built up for shoreside transmission. In step **245**, the processed data is then stored to flash memory, and in step **250** the message is sent to shore. In step **255**, the parameter table is then written to EPROM and in step **260** it is determined whether 30 minutes has elapsed. If so, processing returns to step **215** to repeat the process and collect another 20 minutes of data.

The Wave Processing Algorithms for the Digital Directional Wave Module (DDWM) for computing mean pitch and roll in step **230** and processing collected wave data in step **235** are described as follows. The on-board processing of the Digital Directional Wave Module (DDWM) consists of several modules from the main program illustrated in FIG. **2**. The wave processing is performed with the Process_Waves (Table 1) module within the process.c Program (Appendix A is the Source Code Listing). Process_Directional (Table 2) performs the remainder of the wave processing before results are saved for encoding.

Other routines are used to Save intermediate and final results, perform both the forward and backward FFT depending on the calling argument (R1fft), and Compute mean pitch and roll from the ratio of the horizontal components of acceleration to the vertical component (meanPitchRoll.c, Appendix B for source code) as set forth in step **230** of FIG. **2**.

Once the data are transmitted to the shoreside processing facility, NDBC removes noise that appears in the low-frequencies for fixed or strapped down accelerometers by applying empirically derived algorithms to the measured acceleration spectral densities. The algorithm assumes that the energy in the lowest frequency band (f(n=0)) of the DDWM represents noise from the tilt of the accelerometer. This unwanted noise is amplified when the double integration takes place to compute displacement spectral densities from the acceleration spectral densities.

TABLE 1

Process_Waves Flow	
Load_Arrays	Loads test data from a user specified file and loads it into the data arrays.
↓	
Process_Waves	Handles flow control for wave data processing.
↓	
Calc_Magnetic_Fields	Calculate the magnetic fields B and Bd.
↓	
GetBey	Gets the Earth's magnetic field from buoy measurements.
↓	
Run_Input_Stats	Calculates and displays the mean, minimum, maximum, and standard deviation of the input arrays.
↓	
Stat	Calculates and displays the mean, minimum, maximum, and standard deviation of the specified array.
↓	
Process_Directional	Handles all the processing necessary for a directional wave.

TABLE 2

Processs_Directional Flow	
Setup_Nfreq	Sets up the nfreq data array to be used for spectral analysis.
↓	
NonDirectional_Spectra	Performs non-directional spectral analysis on wave data.
↓	
Noise_Correction	Finds the low frequency cutoff for the integration of the angular rate.
↓	
ARS_pitch and roll	This routine calculates Pitch and Roll from angular rate sensors.
↓	
ARS_XYslope_Azimuth	Calculate azimuth using angular rate pitch and roll.
↓	
Run_Stats_II	Calculates and outputs statistical data on processed data.
↓	
Cross_Spectra	Performs cross spectral analysis on wave data.
↓	